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TITLE: ENERGY PLANNING WITH SOLAR AND CONSERVATION: INDIVIDUAL VALUES AND COMMUNITY CHOICE

AUTHOR(S): Scott A. Noll, LASL
Fred Roach, LASL
Larry Palmiter, National Center for Appropriate Technology
Butte, MT 59701

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LOS ALAMOS SCIENTIFIC LABORATORY

Post Office Box 1663   Los Alamos, New Mexico 87545
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Scott A. Noll
Fred Roach
Los Alamos Scientific Laboratory
P. O. Box 1663
Los Alamos, NM
87545 USA

Larry Palmiter
National Center for
Appropriate Technology
P.O. Box 3838
Butte, MT
59701 USA

ABSTRACT:

Conflict among the priorities of individuals, private sector businesses, and government entities makes the transition to a renewable energy resource base a difficult one. These conflicts are intensified by the overwhelming number of externalities created by the actions of each of these decision making groups. This paper explores the nature of some of these conflicts and externalities and gives an illustrative example of the benefits to be derived from community energy planning. Community energy programs have the potential to stimulate household and community income, create job opportunities, develope a more resilient energy economy, and help mitigate environmental deterioration.

1. INTRODUCTION

The difficulty of shifting our energy resource base from depletable non-renewable energy supplies to abundant renewable energy sources lies in the conflict among individuals, private sector businesses, and government entities. The nature of these conflicts stems from the fact that each of these groups of decision makers has different priorities, responds to different signals existing in the marketplace, and behaves to maintain or improve its own position often at the expense of the position of others.

A factor that further intensifies these conflicts is the overwhelming number of externalities created by the actions of each of the decision making groups: an externality is said to occur when the action of one party has a direct or indirect impact (positive or negative) on the welfare of others.

2. EXAMPLES OF EXTERNALITIES

The following may serve as an illustrative example. Seymour Sunshine owns a home in a rural community and is considering an investment to upgrade the envelope of his home through energy conservation measures. In addition, he would like to undertake some solar retrofit with an attached sunspace and a domestic solar hot water heater. However, Mr. Sunshine is reluctant to pursue any of these investments because he pays fairly low energy bills for natural gas and may have trouble financing the necessary home improvement loan due to his other debts (home mortgage, car, insurance, etc.)

What Mr. Sunshine does not realize is that his decision can have a direct impact on his local community. If he continues to consume large amounts of natural gas, he is in effect transferring money from his pocket directly to the pocket of his utility (assumed to be apart from the city). The utility in turn generates some jobs within the community with an associated income, but by and large, the majority of the income transfer goes to holders of the utility's bonds and equity (in the form of debt repayment or return on equity) and to gas suppliers (producers and interstate distributors). If Mr. Sunshine does make the energy conserving investments he will support local contractors who will use local labor and perhaps some locally supplied (but not necessarily produced) products and he will generate additional income (tax free) for himself through fuel savings. In turn, he will respend a portion of these savings within the community and make the loan payments through a local banking establishment (this does not imply that all of the loan funds are generated locally). To the extent that the value of fuel savings exceeds the loan payments, Mr. Sunshine is better off and additional income is generated within the local economy. If these investments were to be made by a large portion of the community, a significant direct and indirect spending effect could be generated within the community.

However, as mentioned earlier, the individual may face cheap energy prices in his community. In the case of heating oil, natural gas, and electricity the residential

or commercial consumer only pays the average cost of energy. That is, the utility charges the consumer according to a weighted average of the cost of energy supplies that are generated or supplied at various historical costs. Up until 1970, additional increments to electric generating capacity could be supplied at costs below previous increments. In this situation, the average cost of electrical energy declined in real (inflation free) terms. However, after 1970, the economies of scale in large power plant complexes began to reverse, and each additional increment to generating capacity cost more than previous increments. In this situation, average costs which are charged to the consumer include the cheaper generating units built in the past. This means that Mr. Sunshine would be paying electricity rates that are cheaper than if costs were based upon replacement or new marginal generating capacity. In summary, electric utilities are faced with marginal cost requirements, whereas individuals are charged the lower average costs.

Interstate natural gas and heating oil costs also are subject to this disparity. Interstate gas prices are determined from a weighted average of gas supplies, the weights determined by the specific mix of the gas vintages. Vintage refers to the year in which gas came into production from a particular well. Wells of an older vintage are allowed lower maximum ceiling prices, whereas newer wells have been allowed higher ceiling prices presumably because the cost of production (including discovery) per unit of gas extracted has increased. The same situation exists for domestic petroleum production; however, geographic inequities largely were eliminated through the entitlements program which equalizes the costs of lower priced domestic
sources with higher priced imports to refiners in various locations.

The use of average costing implies that the consumer will compare the average costs of a conventional fuel source with the marginal cost of a renewable energy source such as solar. A factor that further aggravates the discrepany is that the average conventional fuel cost includes many direct and indirect subsidies through R&D programs, depletion allowances, and numerous tax accounting laws. Together these two effects cause consumers to make individual choices that often are at odds with the general welfare of the community, state, or nation as a whole.

A complicating dynamic that has been observed, is that when consumers of utility fuel supplies decrease their consumption through energy conserving investments or behavioral changes, the utility receives lesser revenues. In order to cover the fixed costs of indebtedness and provide the allowable (guaranteed) rate of return to its investors, the utility necessarily must incrase the unit cost of energy delivered in order to maintain revenues. The consumer sees these higher prices and may reduce demand even further which only aggravates the situation. However, this is not a problem if the utility can operate its base load generating units at a high annual load factor in order to satisfy backup lighting (not fulfilled by natural daylighting), appliance, and direct electric requirements in the various use sectors. This is because base load plants are dominated by capital expense, whereas the smaller peaking units are dominated by fuel expense. If energy conservation does not detract from base unit loading patterns, the impact on the utility will not be as adverse, and the revenue-price spiral can be mitigated.

In new construction, the incentive to invest additional dollar amounts in energy conservation techniques (ECT's) must rest with the suppliers of the constructed buildings. The supply side of the construction market includes developers, designers and architects, builders and contractors, and materials suppliers. None of these individuals must pay the cost of operating the completed building, except for situations where the developer is the owner; this may be true for certain multi-unit residential or commercial projects.

Without a series of mandates, building performance standards, or zoning requirements, the impetus to build energy conserving homes must come from the market place itself; that is, the builder must perceive a demand for structures that conserve energy but at some additional cost. Passive solar concepts primarily have been developed in the custom home market, where the purchaser usually takes an active role in the design process and is willing to pay the additional expense for passive solar features. No such relationship exists in the speculative market (especially in tract home developments), so the builder must have confidence that solar innovations will be accepted by home-buyers.

With rising energy prices, solar and conservation features in residential housing are beginning to attract attention, but the problems of consumer and supplier uncertainty and indifference remain. Every energy wasteful structure that is built puts an additional economic burden on the buyer and admittedly for some this burden is only a minor concern. However, income is drained out of the local economy, and reliance on conventional non-renewable energy sources is increased.

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3. COMMUNITY ENERGY PLANNING: AN ILLUS-TRATIVE EXAMPLE

In response to these situations, many communities have begun to take an active role in energy planning at the local level. The Davis, California experience is often cited as a prime example and model for ingenuity and initiative with respect to community energy planning. The most important contributing factor to the initiation and continuing success of the Davis program is that energy conservation advocates were elected to form a majority on the city council. With a supportive political climate, individuals within the community were able to initiate creative programs in order to raise the level of energy consciousness and undertake energy conserving measures.

In order to demonstrate the magnitude of benefits that could accrue to a community as a result of energy planning with conservation and solar design, the following illustrative example is put forth.

Sunshine City is a rural, agriculturally based community of 30,000 that is experiencing a healthly degree of growth. The demographic, heating energy use, and fuel type characteristics of Sunshine City are listed in Table I.

A town of this size most likely would have natural gas service, so that new starts could be serviced with electricity, natural gas, or propane. However, because many rural communities may be faced with natural gas curtailments in the future, the propane assumption is used as an alternative to a potentional curtailment situation since it provides the lowest cost available alternative.

The benefits of a limited energy conservation plan initiated by the city council can be estimated by comparing the base case situation (where nothing is done) to a situation that could result from an energy planning program based upon conservation retrofit and passive solar design in new housing starts. The benefits could be magnified further by additional measures such as active or passive solar domestic hot water heating installed on both new and old structures. For simplification, the example is limited to conservation and passive solar design.

The basic elements of the energy program are described in Table II. At the communiy level, bond issues have been used to finance capital expenditures for public goods including schools, airports, hospitals, etc. which generally benefit the users of those services. In addition, indirect benefits are generated which may or may not contribute to community income. Although there is

TABLE I.   CHARACTERISTICS OF SUNSHINE CITY

Demographic

Population:	30,000
Economic Base	Agriculture
Persons per family (average)	3.8
Housing: Current Stock	7875 units
Single Family	6300 units(80%)
Multi-family & apts	1575 units(20%)
New Starts	350 units/year
Single Family Residence	
Average Size	1500 ft^2 (heated)

Heating Energy Use
(Single Family Detached)

Heating Degree Days:	5000
Heat Loss Factors:	
Current Stock	11 Btu/DD/ft^2 or 82.5 MMBtu/yr
New Starts	8 Btu/DD/ft^2 or 60.0 MMBtu/yr
Annual Heating Energy	
Current Stock	519.75 x 10^9 Btu/yr
New Starts	21.00 x 10^9 Btu/yr additional each year

Fuel Types and Cost

Current Stock	50% Electric Resistance Heat
	50% Propane
	Natural Gas Unavailable
New Starts	100% Propane
Cost of Heat Delivered	
Electric Resistance	$17.60/MMBtu
Propane	$ 8.33/MMBtu

no general precedent on a community level to use bond financing to purchase individual privately owned capital, low interest loan bonds have been used to provide cheap money for the private financing of such purchases. In the former case, all community members would pay through taxation for energy conservation and passive solar design which would directly benefit only a portion of the population. However, the remainder of the community would indirectly benefit in terms of additional community income created through the reespending income multiplier effect. In the latter case, the individuals who directly benefit from the capital improvements would bear the burden of loan repayment, although at lower financing costs, while the remainder of the community would benefit from the indirect income effects without bearing the taxation burden.

TABLE II.	THE SUNSHINE CITY PROGRAM FOR CONSERVATION RETROFIT AND PASSIVE SOLAR DESIGN

Program Duration: 15 years

Conservation Retrofit:

Reduce old home energy consumption for heating from 82.5 MMBtu/yr to 60 MMBtu/yr at a cost of $20/MMBtu/yr or $450/home. Retrofit 500 homes/year.

Passive Solar Design:

Reduce new home energy consumption for heating from 60 MMBtu/yr to 30 MMBtu/yr at a cost of $100/MMBtu/yr or $3000/home. Passive design on 1/2 of all new starts or 175 passive homes/year.

Finance:

Pay for the capital investment with three 15 year tax exempt municipal bonds: $3,750,000 per issue at a 6.5% coupon rate issued in the first, sixth, and eleventh years.

In this example, the particular method of financing is not specified; however, it is assumed that three separate bond issues are made in the first, sixth, and eleventh years, totalling $11.75 million (1979 dollars) at a 6.5% coupon rate. Total capital expenditures amount to $750,000/year, 75% of which is spent directly within the community. Interest from the unspent funds is assumed to match the rate of inflation.

Figures 1 and 2 summarize the financial impact on the community over the 15 year program life. Fig. 1 shows that the direct annual capital expense within the community of $562,500/year (1979 dollars) creates annual fuel savings that increase over time because of the passive solar design on new buildings and conservation retrofit on old buildings. These direct expenditures and realized tax free fuel savings create a direct, indirect, and induced income effect which sums to $1.40 for every $1.00 expended in the local economy. This implies a total Type II household income multiplier of 1.4. 75% of the capital expenditures and 90% of the dollar fuel savings are assumed to be respent in the local economy of Sunshine City. Fig 1 shows the annual income created by the direct, indirect, and induced income injected into the economy. This amounts to $.40 of additonal income generated for each $1.00 of direct income expended by households. The annual fuel savings, annual local capital expenditures, and indirect and induced income sum to give the total additional community annual income. This

amounts to about $4.0 million of additional community income per year by the 15th year as a result of the energy conservation and passive design program.

In Fig 2., this gross income is adjusted to reflect the annual bond repayments and foregone respending impacts due to income withdrawal, as well as the displacement effect due to a lower income stream to the utility sector. The sum of these two items yields the total additional community annual expense. However, even with these expenses, the net additional community annual income is positive from the very first year and accumulates to over $28 million by the end of the 15th year.

4. CONCLUSIONS

Although many simplifying assumptions are made in the Sunshine City example, the results of this and other analyses point to the fact that substantial community benefits can be obtained as a result of local energy planning. Community income can be bolstered, job opportunities can be created, local energy self reliance can be improved, and environmental degradation can be retarded. Communities have the potential to exert a much more creative force in our nation's energy future than has been done in the past. Fiscal tools can be combined with the zoning and planning functions to provide a substantial stimulus to local energy conservation programs. However, the success of each community in this regard lies largely in the hands of the local politicians who exert control over the budget and planning functions of local government. If forward looking energy conscious individuals do not form a majority coalition in these power groups, the involvement of communities will be delayed; and each year of delay imposes additional negative externalities on individuals, communities, and the nation as a whole because opportunities to reverse our dependence on non-renewable energy resources are forever lost.

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FIG. 1 DOLLAR IMPACTS OF THE SUNSHINE CITY CONSERVATION AND PASSIVE SOLAR PROGRAM (1979 $)

FIG. 2 NET DOLLAR IMPACTS OF THE SUNSHINE CITY CONSERVATION AND PASSIVE SOLAR PROGRAM (1979 $)